

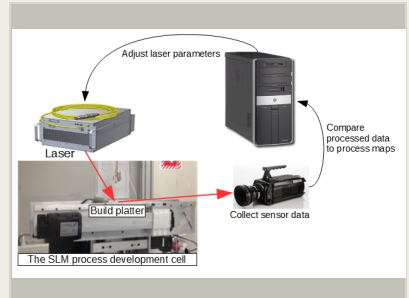
## In-Process Monitoring of Additive Manufacturing, Phase II

Completed Technology Project (2015 - 2019)



## Project Introduction

In Phase I of this project MLPC, WSU, and AFIT were successfully able to identify several optical data features that are indicative of the quality of components built with the selective laser melting additive manufacturing process. Four unique optical sensors were identified to collect this information and they include infrared and visible wavelength high-speed cameras and spectrometers. The sensors used in Phase I were very expensive, university developed, and produce very big data sets. In this phase II proposal MLPC and their collaborators will continue this work by developing a new low-cost sensor system to specifically track key data features identified in Phase I. This sensor system will then be used to perform in-process quality monitoring and qualification of manufactured parts. In Phase II this analysis will also be extended to electron beam freeform fabrication. To complete the project MLPC, WSU, and AFIT will continue analysis of the Phase I sensor data to identify more obscure process quality data, and develop process maps that correlate sensor output to part microstructure. Then MLPC and AFIT will design and build the low-cost sensor system to track all key data, and test it on MLPCs custom build additive manufacturing test cell. Next MLPC will perform the necessary programming and data processing to implement a process monitoring system that will show sensor data position on the process maps in real-time, thus enabling in-process quality assurance. MLPC will then study and report the cost savings NASA could gain with this technology. Finally, MLPC will test this concept on an electron beam system and determine its viability for that process. At the end of Phase II the TRL will be 5, and this product will be ready for licensing for commercial use in existing additive manufacturing machines, and the MLPC developed additive manufacturing system will be available for licensing as a package unit with the integrated sensor system.



In-Process Monitoring of Additive Manufacturing, Phase II Briefing Chart Image

## Table of Contents

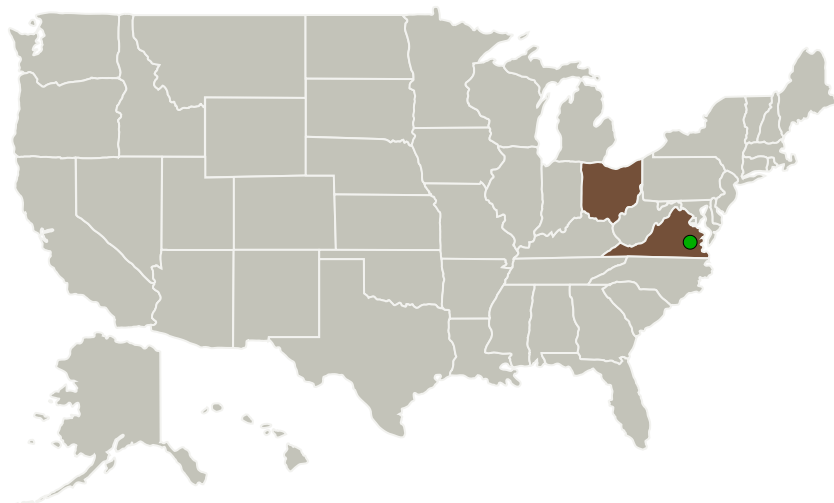
Project Introduction	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Images	3
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

## In-Process Monitoring of Additive Manufacturing, Phase II

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Advratech LLC	Lead Organization	Industry	Dayton, Ohio
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
Wright State University-Main Campus	Supporting Organization	Academia	Dayton, Ohio

## Primary U.S. Work Locations

Ohio	Virginia
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## Project Transitions

▶ **July 2015:** Project Start

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Advratech LLC

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

John R Middendorf

**Co-Investigator:**

John Middendorf

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✓ **May 2019:** Closed out

## Closeout Documentation:

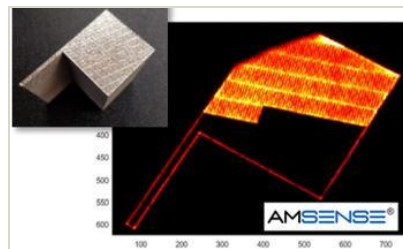
- Final Summary Chart(<https://techport.nasa.gov/file/138203>)

## Images



### Briefing Chart Image

In-Process Monitoring of Additive Manufacturing, Phase II Briefing Chart Image  
(<https://techport.nasa.gov/image/134468>)

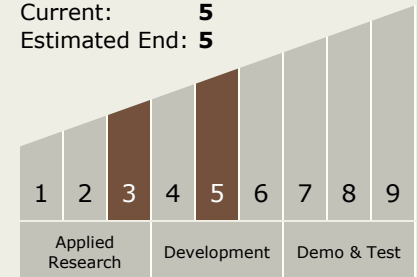


### Final Summary Chart Image

In-Process Monitoring of Additive Manufacturing, Phase II  
(<https://techport.nasa.gov/image/130247>)

## Technology Maturity (TRL)

Start: **3**  
Current: **5**  
Estimated End: **5**



## Technology Areas

### Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.4 Manufacturing
    - TX12.4.1 Manufacturing Processes

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System